

Amendments

1 - 49. (Canceled)

50. (New) A process comprising:

providing a distillation column reactor comprising oxidation catalyst between a distillation zone and a reaction zone;

feeding liquid benzene to the reaction zone;

feeding oxidant gas to the distillation zone;

contacting benzene and oxidant gas with the oxidation catalyst under oxidation conditions effective to catalytically hydroxylate at least a portion of the benzene to produce hydroxylated product.

51. (New) The method of claim 50 further comprising separating hydroxylated product from the distillation zone.

52. (New) The method of claim 50 wherein the oxidation catalyst comprises zeolite catalyst.

53. (New) The method of claim 51 wherein the oxidation catalyst comprises zeolite catalyst.

54. (New) The method of claim 50 wherein the oxidation conditions comprise a temperature of from above 100°C to 270°C.

55. (New) The method of claim 51 wherein the oxidation conditions comprise a temperature of from above 100°C to 270°C.

56. (New) The method of claim 53 wherein the oxidation conditions comprise a temperature of from above 100°C to 270°C.

57. (New) The method of claim 51 wherein the separating hydroxylated product from the distillation zone comprises

maintaining un-reacted benzene in the distillation zone under conditions effective to vaporize the un-reacted benzene and maintain hydroxylated product in a liquid phase; and

recovering at least a portion of the liquid phase from the distillation zone.

58. (New) The method of claim 53 wherein the separating hydroxylated product from the distillation zone comprises

maintaining un-reacted benzene in the distillation zone under conditions effective to vaporize the un-reacted benzene and maintain hydroxylated product in a liquid phase; and
recovering at least a portion of the liquid phase from the distillation zone.

59. (New) The method of claim 56 wherein the separating hydroxylated product from the distillation zone comprises
maintaining un-reacted benzene in the distillation zone under conditions effective to vaporize the un-reacted benzene and maintain hydroxylated product in a liquid phase; and
recovering at least a portion of the liquid phase from the distillation zone.

60. (New) The process of claim 57 wherein said recovering at least a portion of the liquid phase from the distillation zone comprises substantially continuous fractional distillation.

61. (New) The process of claim 59 wherein said recovering at least a portion of the liquid phase from the distillation zone comprises substantially continuous fractional distillation.

62. (New) The process of claim 50 wherein the oxidant gas is selected from the group consisting of nitrous oxide, oxygen, air, and mixtures thereof.

63. (New) The process of claim 59 wherein the oxidant is selected from the group consisting of nitrous oxide, oxygen, air, and mixtures thereof.

64. (New) The process of claim 50 wherein the oxidant gas comprises nitrous oxide.

65. (New) The process of claim 53 wherein the oxidant gas comprises nitrous oxide.

66. (New) The process of claim 56 wherein the oxidant gas comprises nitrous oxide.

67. (New) The process of claim 59 wherein the oxidant gas comprises nitrous oxide.

68. (New) The process of claim 50 wherein the oxidation conditions comprise a temperature of from about 185 °C. to about 270 °C.

69. (New) The process of claim 53 wherein the conditions comprise a temperature of from about 185 °C. to about 270 °C.

70. (New) The process of claim 59 wherein the conditions comprise a temperature of from about 185 °C. to about 270 °C.

71. (New) The process of claim 63 wherein the conditions comprise a temperature of from about 185 °C. to about 270 °C.

72. (New) The process of claim 50 wherein selectivity for conversion of the oxidant gas to hydroxylated product is at least 90 mol %.

73. (New) The process of claim 59 wherein selectivity for conversion of the oxidant gas to hydroxylated product is at least 90 mol %.

74. (New) The process of claim 59 wherein selectivity for conversion of the oxidant to hydroxylated product is at least 95 mol %.

75. (New) The process of claim 50 wherein the oxidation catalyst comprises zeolite catalyst comprising at least one metal selected from the group consisting of ruthenium, rhodium, iridium, iron, magnesium, cobalt, copper, titanium, vanadium, manganese, niobium, and mixtures thereof.

76. (New) The process of claim 56 wherein the oxidation catalyst comprises zeolite catalyst comprising at least one metal selected from the group consisting of ruthenium, rhodium, iridium, iron, magnesium, cobalt, copper, titanium, vanadium, manganese, niobium, and mixtures thereof.

77. (New) The process of claim 59 wherein the oxidation catalyst comprises zeolite catalyst comprising at least one metal selected from the group consisting of ruthenium, rhodium, iridium, iron, magnesium, cobalt, copper, titanium, vanadium, manganese, niobium, and mixtures thereof.

78. (New) The process of claim 63 wherein the oxidation catalyst comprises zeolite catalyst comprising at least one metal selected from the group consisting of ruthenium, rhodium, iridium, iron, magnesium, cobalt, copper, titanium, vanadium, manganese, niobium, and mixtures thereof.

79. (New) The process of claim 75 wherein the zeolite catalyst comprises the metal in an amount of from about 0.01 wt % to about 5 wt%.

80. (New) The process of claim 76 wherein the zeolite catalyst comprises metal in an amount of from about 0.01 wt % to about 5 wt%.

81. (New) The process of claim 77 wherein the zeolite catalyst comprises metal in an amount from about 0.01 wt % to about 5 wt%.

82. (New) The process of claim 78 wherein the zeolite catalyst comprises metal in an amount from about 0.01 wt % iron to about 5 wt% iron.

83. (New) The process of claim 50 wherein the oxidation conditions comprise a temperature of from about 185 °C. to about 270 °C.

84. (New) The process of claim 82 wherein the oxidation conditions comprise a temperature of from about 185 °C. to about 270 °C.

85. (New) The process of claim 83 wherein the oxidation conditions comprise a benzene partial pressure in the range of from about 0.1 atm to about 45 atm.

86. (New) The process of claim 84 wherein the oxidation conditions comprise a benzene partial pressure in the range of from about 0.1 atm to about 45 atm.

87. (New) The process of claim 50 further comprising withdrawing unreacted benzene and oxidant gas as overhead.

88. (New) The process of claim 50 wherein the temperature of the distillation zone is higher than the boiling point of benzene and lower than the boiling point of phenol.

89. (New) The process of claim 63 wherein the temperature of the distillation zone is higher than the boiling point of benzene and lower than the boiling point of phenol.

90. (New) The process of claim 85 wherein the temperature of the distillation zone is higher than the boiling point of benzene and lower than the boiling point of phenol.

91. (New) The process of claim 86 wherein the temperature of the distillation zone is higher than the boiling point of benzene and lower than the boiling point of phenol.

92. (New) A process comprising
providing a distillation column reactor comprising oxidation catalyst between a
distillation zone and a reaction zone;

feeding liquid benzene to the reaction zone;

feeding oxidant gas to the distillation zone;

contacting the benzene and the oxidant gas with the oxidation catalyst under oxidation conditions effective to catalytically hydroxylate at least a portion of the benzene to produce hydroxylated product, the oxidation conditions comprising a temperature of from above 100°C to 270°C and a benzene partial pressure in the range of from about 0.1 atm to about 45 atm.;

separating hydroxylated product from the distillation zone.

93. (New) The method of claim 92 wherein separating hydroxylated product from the distillation zone comprises

maintaining un-reacted benzene in the distillation zone under conditions effective to vaporize the un-reacted benzene and maintain hydroxylated product in a liquid phase; and

recovering at least a portion of the liquid phase from the distillation zone.

94. (New) The process of claim 92 wherein the separating hydroxylated product from the distillation zone comprises substantially continuous fractional distillation.

95. (New) The process of claim 93 wherein the separating hydroxylated product from the distillation column reactor comprises substantially continuous fractional distillation.

96. (New) The process of claim 92 wherein the oxidant gas is selected from the group consisting of nitrous oxide, oxygen, air, and mixtures thereof.

97. (New) The process of claim 93 wherein the oxidant gas is selected from the group consisting of nitrous oxide, oxygen, air, and mixtures thereof.

98. (New) The process of claim 95 wherein the oxidant gas is selected from the group consisting of nitrous oxide, oxygen, air, and mixtures thereof.

99. (New) The process of claim 92 wherein the oxidant gas comprises nitrous oxide.

100. (New) The process of claim 93 wherein the oxidant gas comprises nitrous oxide.

101. (New) The process of claim 95 wherein the oxidant gas comprises nitrous oxide.

102. (New) The process of claim 92 wherein the oxidation conditions comprise a temperature of from about 185 °C. to about 270 °C.

103. (New) The process of claim 99 wherein the conditions comprise a temperature of from about 185 °C. to about 270 °C.

104. (New) The process of claim 100 wherein the conditions comprise a temperature of from about 185 °C. to about 270 °C.

105. (New) The process of claim 101 wherein the conditions comprise a temperature of from about 185 °C. to about 270 °C.

106. (New) The process of claim 92 wherein selectivity for conversion of the oxidant gas to hydroxylated product is at least 90 mol %.

107. (New) The process of claim 92 wherein selectivity for conversion of the oxidant gas to hydroxylated product is at least 95 mol %.

108. (New) The process of claim 92 wherein the oxidation catalyst comprises a zeolite catalyst comprising at least one metal selected from the group consisting of ruthenium, rhodium, iridium, iron, magnesium, cobalt, copper, titanium, vanadium, manganese, niobium, and mixtures thereof.

109. (New) The process of claim 100 wherein the oxidation catalyst comprises a zeolite catalyst comprising at least one metal selected from the group consisting of ruthenium, rhodium, iridium, iron, magnesium, cobalt, copper, titanium, vanadium, manganese, niobium, and mixtures thereof.

110. (New) The process of claim 101 wherein the oxidation catalyst comprises a zeolite catalyst comprising at least one metal selected from the group consisting of ruthenium, rhodium, iridium, iron, magnesium, cobalt, copper, titanium, vanadium, manganese, niobium, and mixtures thereof.

111. (New) The process of claim 105 wherein the oxidation catalyst comprises a zeolite catalyst comprising at least one metal selected from the group consisting of ruthenium, rhodium, iridium, iron, magnesium, cobalt, copper, titanium, vanadium, manganese, niobium, and mixtures thereof.

112. (New) The process of claim 108 wherein the zeolite catalyst comprises the metal in an amount of about 0.01 wt % to about 5 wt%.

113. (New) The process of claim 109 wherein the zeolite catalyst comprises metal in an amount of from about 0.01 wt % to about 5 wt%.

114. (New) The process of claim 110 wherein the zeolite catalyst comprises metal in an amount from about 0.01 wt % to about 5 wt%.

115. (New) The process of claim 111 wherein the zeolite catalyst comprises metal in an amount from about 0.01 wt % iron to about 5 wt% iron.

116. (New) The process of claim 92 wherein the oxidation conditions comprise a temperature of from about 185 °C. to about 270 °C.

117. (New) The process of claim 115 wherein the oxidation conditions comprise a temperature of from about 185 °C. to about 270 °C.

118. (New) The process of claim 92 further comprising withdrawing unreacted benzene and oxidant gas as overhead.

119. (New) The process of claim 92 wherein the temperature of the distillation zone is higher than the boiling point of benzene and lower than the boiling point of phenol.

120. (New) The process of claim 92 wherein selectivity for conversion of nitrous oxide to phenol is at least about 90 mol %.

121. (New) The process of claim 92 wherein the zeolite catalyst comprises from about 0.01 wt % to about 5 wt% of at least one metal selected from the group consisting of ruthenium, rhodium, iridium, titanium, magnesium, cobalt, copper, vanadium, manganese, niobium, and iron.

122. (New) The process of claim 105 wherein the zeolite catalyst comprises from about 0.01 wt % to about 5 wt% of at least one metal selected from the group consisting of ruthenium, rhodium, iridium, titanium, magnesium, cobalt, copper, vanadium, manganese, niobium, and iron.

123. (New) A process comprising
providing a distillation column reactor comprising oxidation catalyst located
between a distillation zone and a reaction zone, the oxidation catalyst
comprising zeolite catalyst comprising from about 0.01 wt % to about 5

wt% of at least one metal selected from the group consisting of ruthenium, rhodium, iridium, titanium, magnesium, cobalt, copper, vanadium, manganese, niobium, and iron;

feeding liquid benzene to the reaction zone;

feeding nitrous oxide to the distillation zone;

contacting the benzene and the oxidant gas with the oxidation catalyst under oxidation conditions effective to catalytically hydroxylate at least a portion of the benzene to produce hydroxylated product comprising phenol, the oxidation conditions comprising a temperature of from above 100°C to 270°C and a benzene partial pressure in the range of from about 0.1 atm to about 45 atm;

separating liquid phenol from the distillation zone.

124. (New) The process of claim 123 wherein the temperature of the distillation zone is higher than the boiling point of benzene and lower than the boiling point of phenol.

125. (New) The process of claim 137 wherein the at least one metal comprises iron.

126. (New) The process of claim 125 wherein the zeolite catalyst comprises from about 0.1 wt. % iron to about 1.0 wt. % iron.

127. (New) The process of claim 126 wherein the zeolite is an aluminosilicate produced without addition of boron.

128. (New) The process of claim 123 wherein the separating liquid phenol from the distillation zone comprises substantially continuous fractional distillation.

129. (New) The process of claim 127 wherein the separating liquid phenol from the distillation zone comprises substantially continuous fractional distillation.

130. (New) The process of claim 123 wherein the oxidation conditions comprise a temperature of from about 185 °C. to about 270 °C.

131. (New) The process of claim 129 wherein the conditions comprise a temperature of from about 185 °C. to about 270 °C.

132. (New) The process of claim 123 wherein selectivity for conversion of the oxidant gas to hydroxylated product is at least 90 mol %.

133. (New) The process of claim 123 wherein selectivity for conversion of the oxidant gas to hydroxylated product is at least 95 mol %.

134. (New) The process of claim 123 wherein the zeolite catalyst comprises at least one zeolite having a structural type selected from the group consisting of MFI, MEL, FER, FAU, BEA, MFS, NES, MOR, MTT, MWW, EUO, OFF, MTW and zeolites ITQ-1, ITQ-2, MCM-56, MCM-49, ZSM-48, SSZ-35, SSZ-39, and PSH-3 and mixtures thereof.

135. (New) The process of claim 127 wherein the zeolite catalyst comprises at least one zeolite having a structural type selected from the group consisting of MFI, MEL, FER, FAU, BEA, MFS, NES, MOR, MTT, MWW, EUO, OFF, MTW and zeolites ITQ-1, ITQ-2, MCM-56, MCM-49, ZSM-48, SSZ-35, SSZ-39, and PSH-3 and mixtures thereof.

136. (New) The process of claim 129 wherein the zeolite catalyst comprises at least one zeolite having a structural type selected from the group consisting of MFI, MEL, FER, FAU, BEA, MFS, NES, MOR, MTT, MWW, EUO, OFF, MTW and zeolites ITQ-1, ITQ-2, MCM-56, MCM-49, ZSM-48, SSZ-35, SSZ-39, and PSH-3 and mixtures thereof.

137. (New) The process of claim 131 wherein the zeolite catalyst comprises at least one zeolite having a structural type selected from the group consisting of MFI, MEL, FER, FAU, BEA, MFS, NES, MOR, MTT, MWW, EUO, OFF, MTW and zeolites ITQ-1, ITQ-2, MCM-56, MCM-49, ZSM-48, SSZ-35, SSZ-39, and PSH-3 and mixtures thereof.